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The identity and taxonomic status of *Tilapia arnoldi* Gilchrist and Thompson, 1917 (Teleostei, Cichlidae)

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CONTENTS

Synopsis The type and only specimen of *Tilapia arnoldi* Gilchrist and Thompson (1917) is redescribed (as far as its poor condition allows) and its taxonomic status reassessed in the light of that study. It is concluded that *T. arnoldi* should be considered a junior subjective synonym of *Tilapia sparrmanii* A. Smith, 1840, and not, as previously thought, of *Oreochromis mossambicus* (Peters), 1852.

INTRODUCTION

Tilapia arnoldi was described by Gilchrist and Thompson (1917) on the basis of a single specimen collected by G. Arnold from the Mazui River, Zimbabwe. Their description, although detailed, lacks a figure, and no specifically diagnostic features are given. However, in a synopsis of the Southern African cichlid species described in that paper the authors paired *Tilapia arnoldi* with a taxon then considered to be *T. melanopleura* Dum., 1859, but which is now identified as *T. rendalli* (Blgr.) 1896 (see Thys van den Audenaerde, 1964).

In Gilchrist and Thompson's synoptic key, *T. arnoldi* is distinguished from *T. rendalli* by its having a lower lateral-line scale count (27 *cf* 28–32) and a higher number of gill-rakers on the lower part of the anterior gill-arch (i.e. 15 *cf* 8–12).

Regan (1922), without examining the type specimen of *T. arnoldi*, and without giving any reasons for his opinion, suggested that '*T. arnoldi* may be a synonym of *Tilapia natalensis*' (*T. natalensis* [Weber] 1897 is now consider a synonym of *Oreochromis mossambicus* [Peters] 1852; see Trewavas [1983] for a detailed synonymy).

There matters stood until Barnard (1948*a*: 49 and 54, *b*: 448) formally synonymised *T. arnoldi* with *O. mossambicus* (then *Tilapia mossambica*). Again no reasons were given, but judging from Barnard's (1948 *a,b*) key to the southern African *Tilapia* species it was the supposed number of gill-rakers (i.e. 15) and the general morphology of *T. arnoldi* that prompted his action.

Barnard's synonymy has been accepted by subsequent workers (Jackson, 1961; Jubb, 1961, 1967), although Trewavas (1983) omits, without comment, any specific reference to *T. arnoldi* in her detailed synonymy of *O. mossambicus*. However, since she gives references, again without comment, to the Jubb and Jackson papers in that synonymy, one can assume, at least by implication, she too accepted Barnard's conclusions. Only Bell-Cross and Minshull (1988) have departed from this consensus; they list *T. arnoldi* under *T. sparrmanii* in their check-list, but give no reasons for so doing.

I have recently examined the holotype of *T. arnoldi* and, despite its now very poor condition (see Fig. 1), have concluded that it is conspecific with *Tilapia sparrmanii* A. Smith, 1840 and thus should be considered a junior subjective synonym of that species.

Throughout this paper most further references to Gilchrist and Thompson (1917) will, in the interests of brevity, be abbreviated to 'G & T', and references to the papers of Thys van den Audenaerde will be cited as 'Thys'.

MATERIAL AND METHODS

The system of counts and measurements employed follows that detailed by Trewavas (1983).

The length of the lower pharyngeal bone is measurd, perpendicularly, from the anterior tip of the blade to a horizontal line through the posterior margin of the bone's dentigerous surface; the overall breadth of the bone is taken as the horizontal distance between the outer tips of its articular horns.

Various diagnostic tilapiine features used by Thys (1964, 1968) and Trewavas (1983) at both the generic and specific levels have been used, as was information contained in the more general accounts of *T. sparrmanii, T. rendalli* (A.

Fig. 1 *Tilapia arnoldi* holotype in left lateral view. Actual standard length: 46.0 mm.

Dum.), *T. ruweti* (Poll and Thys) and *O. mossambicus* given by Jubb (1967) and by Bell-Cross and Minshull (1988).

Specimens used for comparative purposes are:

Tilapia arnoldi: holotype, South African Museum (SAM) 10862; now housed in the Albany Museum, Grahamstown, under that number.

Tilapia rendalli: J. L. B. Smith Institute of Ichthyology, Grahamstown (RUSI) 26579; a single specimen from the Incomati river; RUSI 27988, 3 specimens from the Sabi River, Kruger National Park.

Tilapia ruweti: RUSI 30126, a single specimen from the Thamalakane River, Okovango, Botswana; 10 specimens from lot RUSI 30343, Gomoti system, Okovango, Botswana.

Tilapia sparrmanii: RUSI 22600, 3 specimens from the Palala River, Limpopo River system at Muisvogelkraal 20° 00′S, 24° 30′E, Transvaal.

Oreochromis mossambicus: RUSI 26135, 7 specimens from weir R2M 10, above Laing Dam (Fort Murray), Buffalo River system, Eastern Cape Province.

All specimens of the four latter species are of approximately the same size as the type of *T. arnoldi*, and were chosen for that reason.

REDESCRIPTION OF *T. ARNOLDI* HOLOTYPE

The specimen is now in very poor condition (Fig. 1) having at some time been partially dried-out and suffered fairly extensive damage to the body and unpaired fins. It is also partly cleared since the alimentary tract is readily visible through the body wall. No trace of chromatophores remains on the body and fins, all of which are now a light caramel-brown in colour. Unfortunately the preserved coloration and colour-patterns as described by G & T are of no taxonomic value.

The head is extensively damaged and almost detached from the body; the right operculum and suboperculum are missing, as is the entire lower jaw. Some branchiostegal rays have been lost on both sides, and the branchiostegal membrane is badly torn; the complete hyoid arch, including the urohyal is, however, present.

All four gill-arches are preserved on the left side, but only the third and fourth arches remain on the right; what seems to be the second arch of that side is detached and lies loose in the jar. The remnants of the pharyngobranchial skeleton have lost their attachment to the skull and pectoral girdle. The lower pharyngeal bone was still attached to the upper pharyngeal elements, but has now been dissected-out for detailed examination.

Damage to most of the fins is also extensive. The upper half of the caudal fin is missing and the distal portions of all but three branched dorsal fin rays broken off, as are all the branched anal rays, although these are still attached to the fin proximally. The pelvic fins are virtually undamaged, as is the right pectoral fin; the left pectoral, however, is broken distally.

With the aid of radiographs, and using the undamaged fins, the following ray counts and measurements can be made: Dorsal with 15 spinous and 11 branched rays; the penultimate and ultimate spines are the longest of the series, are of equal length, and are as long as the third anal spine. Pelvic fins 12.0 mm in length, their tips reaching the anus but not extending to the first anal spine insertion. Pectoral fin (right) *ca* 14 mm long, its tip reaching a vertical through the anus but not to that through the insertion of the first anal spine.

On the left side most scales are missing from the anterior part of the body below the upper lateral-line, but the squamation is fairly complete over the entire right side and on the posterior part of the left side. All scales are cycloid, those on the flank below the lateral-line over approximately the anterior half of the body have moderately rugose exposed surfaces. There is a very gradual transition in size between the antero-ventral scales on the flanks and those situated laterally and ventrally on the chest. Consequently the chest scales, especially in the midline, are not markedly smaller than the scales lying above them.

The upper section of the lateral-line has 15 pored scales, the lower part 11 or possibly 12; the lateral scale count is 26 or 27. There are two rows of imbricating scales on the cheeks, and these completely cover the underlying muscles. Although it is difficult to make a precise count because of damage to the caudal peduncle, there are apparently not more than 14 circumpeduncular scales. No circumpeduncular count was given by Gilchrist and Thompson, but our other counts are in close agreement except for a difference of 3 in the pored scales of the upper lateral-line.

Body measurements which could be made with any degree of accuracy are: Standard length (S. L.) 46.0 mm; head length (H. L.) *ca* 15 mm (i.e. about 33.3% of S. L.); body depth *ca* 23 mm (i.e. about 50% of S. L.). Preorbital depth 3.0 mm (i.e. about 20% of H. L.), least interorbital width 6.0 mm (i.e. about 40% of H. L.), eye, measured as the horizontal diameter of the bony orbital margin, 6.0 mm (i.e. about 40% of H. L.), depth of cheek 3.0 mm (i.e. about 20% of H. L.). Depth of caudal peduncle 1.3 times its length.

These proportional measurements, most of which were taken between bony fixed points, agree with those given by G & T, as do those for the pelvic and pectoral fins. The length (46.0 mm), however, is two millimetres less than recorded by G & T, but that difference could well be attributed to shrinkage with time, and the fact that the head is now almost free from the body.

Shrinkage and damage would not account for the difference in our counts of branched anal fin rays (11 *cf* 9 according to G & T: see p. 72 above). This discrepancy probably is due to the difficulty often encountered in deciding whether the last two or three rays of this fin are separate entities or branches of a single ray. The radiograph now available clearly shows 11 separate rays.

The gill-rakers were described by G & T as short and thick, with 15 on the lower part of the first arch. The holotype now has only the first gill-arch of the left-side remaining. The upper eight outer-row rakers on the lower (ceratobranchial) part of this arch are now fine and slender structures, the three lower rakers being short and flaccid.

Desiccation and poor preservation could well account for this alteration in gill-raker shape, but not for there being 11 instead of 15 rakers on the lower part of the arch. Since the spacing of the eleven rakers is regular and without gaps, and there is no damage to the surface of the arch, it seems very unlikely that four rakers have been lost by shrinkage or any other cause. Thus one must assume that G & T's count of 15 is an error, perhaps resulting from the inadvertent inclusion of upper (i.e. epibranchial) rakers in their count. Unfortunately that supposition cannot be checked because much of the skin covering the epibranchial has been lost and only the lowermost epibranchial raker now remains.

There also remains the problem of why Barnard (1948 *a,b*) too gave a count of 15 rakers since he had the holotype available for study. I can only proffer the suggestion that he accepted Regan's (1922) opinion, based solely on G & T's paper, and did not check the actual number of rakers.

The lower jaw of *T. arnoldi* holotype is now missing, so dental characteristics can only be determined from the premaxillary teeth. Outer row teeth on this bone are unequally bicuspid, with the very small minor cusp rather bluntly conical, and the crown of the major cusp obliquely truncate and not drawn-out. In other words, these teeth have a form common amongst many *Tilapia* and other tilapiine species (see figures in Thys, 1964, and Trewavas, 1983). Apparently no teeth are missing from this row, and their total number is 36, a figure much lower than the 'about 50 in the upper jaw' given by G & T.

Inner row premaxillary teeth are arranged irregularly in 2 or 3 series anteriorly and antero-laterally, and in a single row posteriorly. All are small and equally tricuspid.

Since the lower pharyngeal bone was still *in situ* until I removed it, one can assume that previous workers had not studied the bone in any detail, especially as none has described it or the pharyngeal dentition

The bone's dentigerous surface is broadly and almost equilaterally triangular in outline (Fig. 2). Its posterior margin is gently biconvex, with the convexities joined medially by a short and shallow concavity. The overall width of the bone is slightly greater than its length and the anterior blade slightly shorter than the median tooth row.

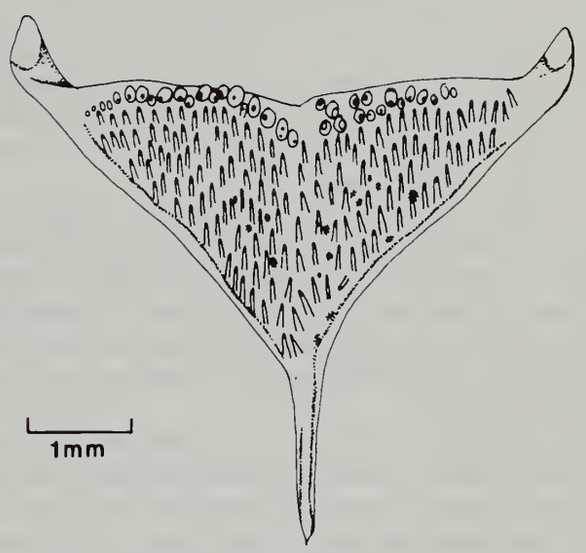

Fig 2. *Tilapia arnoldi* holotype. Lower pharyngeal bone in occlusal view. Drawn by Elaine Grant.

Except for the large, distinctly more robust and clearly bicuspid teeth of the two posterior transverse tooth-rows, all other lower pharyngeal teeth are slender and moderately spaced, are 'kukri'-shaped (see fig. 30 in Greenwood, 1987) and very weakly bicuspid.

Only one osteological character of note is revealed by the radiographs, namely that there are 27 vertebrae, comprising 14 abdominal and 13 caudal elements (including the urostylar centrum).

THE TAXONOMIC STATUS OF *TILAPIA ARNOLDI*

Because neither Regan (1922) nor Barnard (1948 *a,b)* gave reasons for, respectively, their suggested or actual synonymising of *T. arnoldi* with *Oreochromis mossambicus* it is impossible to tell what particular character or character combination shared by the two taxa led to those decisions. With hindsight it seems likely that the reasons lay mainly in the supposed number of gill-rakers in *T. arnoldi* (15 according to G & T), and possibly in its low number of cheek scale rows.

However, despite the present poor condition of *T. arnoldi* holotype, I am certain that there were only 11 rakers on the lower limb of the first gill-arch, a number below that of the

fewest (14) recorded in *O. mossambicus*, and then very rarely. Furthermore, two rows of cheek scales are of rare occurrence in *O. mossambicus*, in which species three rows are modal and two rows are rarely encountered (Trewavas, 1983: 295; personal observations).

Thus neither of these features can be used to identify the specimen as *O. mossambicus*, and there are no other meristic or morphometric features of *T. arnoldi* which are diagnostic for *O. mossambicus*.

The proportions and shape of the lower pharyngeal bone in *T. arnoldi* can also be used to argue against the holotype being identified as a member of the species *O. mossambicus*. Indeed, these features indicate that the specimen is not even a member of the genus *Oreochromis* as currently defined, and that it should be referred to the genus *Tilapia (sensu* Trewavas 1983). In *Oreochromis* species the blade of the bone is as long as, and generally longer than, the median tooth row, and the bone's overall length is noticeably greater than its width (see Thys, 1964, 1968; Trewavas, 1983). In *T. arnoldi*, as in other members of the genus *Tilapia*, these ratios are reversed and the length of blade visibly contributes less to the bone's overall length than it does in species of *Oreochromis* (see Thys, 1964: fig. 5).

When the lower pharyngeal dentition of *Tilapia arnoldi* holotype is compared with that of comparable-sized *O. mossambicus* specimens, the teeth in *T. arnoldi* are seen to be more widely spaced and relatively coarser. In these respects the teeth closely resemble those of *Tilapia sparrmanii* and *T. rendalli* (whose pharyngeal bone's proportions are also like those in *T. arnoldi*).

Tilapia arnoldi also differs from *Oreochromis mossambicus* in two other features, namely its vertebral count and the size of its chest scales relative to those on the antero-ventral aspects of the flanks and anterior belly region. In *O. mossambicus* the range of vertebral numbers is from 28 to 31, with only three of the 23 specimens examined having 28 vertebrae (Trewavas, 1983). The count in *T. arnoldi* holotype is 27. The chest scales in *O. mossambicus* are noticeably smaller than those on the antero-ventral flanks and belly, whereas in *T. arnoldi* the chest scales are but slightly smaller.

Finally, mention should be made of three further features which distinguish the two species, namely the shorter pectoral fin (reaching the anus in *T. arnoldi* but to the first or second anal spine in comparable-sized *O. mossambicus*), the lower lateral scale count in *T. arnoldi* (26 or 27 *cf* 30–32), and the larger eye and wider interorbital in that species (data from personal observations and Trewavas, 1983).

Taken in concert, the characteristics discussed above strongly indicate that the type specimen of *T. arnoldi* is not conspecific with *Oreochromis mossambicus*, while, as noted earlier, the nature of its pharyngeal bone and dentition show that it is a member of the genus *Tilapia*.

If those conclusions are accepted, there remains the question of its specific identity within the genus *Tilapia*. On zoogeographical grounds and on the overall levels of morphological similarity in preserved specimens, the resolution of that problem involves comparisons with *Tilapia rendalli, T. sparrmanii* and *T. ruweti*, the two former species being widely distributed in the Zambezi system, the latter, in Zimbabwe, restricted to the Upper Zambezi river (Bell-Cross and Minshull, 1988).

Tilapia ruweti is readily distinguishable from *T. arnoldi* by its shallower body and rounded dorsal head profile, shorter and distinctly rounded pectoral fin (not reaching the level of the anus), 3 or 4 (*cf* 2) rows of cheek scales, fewer (6–8 *cf* 11) gill-rakers which also appear to be shorter and stouter in *T. ruweti* (although this difference could be a consequence of the poor conditon of *T. arnoldi* holotype) and, at least in specimens of a similar size, by its having the eye diameter about three-quarters that of the interorbital width and not equal to it as in *T. arnoldi*.

In many respects *T. arnoldi* closely resembles *T. rendalli*, but it differs in its larger scales as evidenced by the lateral scale count of 26 or 27 *cf* 29–32 in *T. rendalli*, the circumpeduncular count of 13 or 14 *cf* 16 and by the larger size of the scales on the ventral aspect of the chest. The two taxa also differ in the posterior extent of the pectoral fin which, in *T. rendalli*, reaches to the level of the first, or even the second anal fin spine, but only to the level of the anus in *T. arnoldi*. At least in specimens of a comparable size, the teeth situated anteriorly and antero-laterally in the outer premaxillary row are larger (i.e. have wider tips) than those in *T. arnoldi*, with the result that *T. rendalli* has 26–30 teeth in the outer row, whereas there are 36 in *T. arnoldi*.

None of the features distinguishing *T. arnoldi* from *T. ruweti* and *T. rendalli* serves to distinguish that species from *T. sparrmanii*, and I can find no others which do so. Furthermore the vertebral count in *T. arnoldi* (27) is that modal for *T. sparrmanii* and not for *T. rendalli* (28), although the ranges in both these species do overlap (26–28 and 27–29 for the taxa respectively).

On the basis of the similarity between *T. arnoldi* and *T. sparrmanii*, and in the absence of any detectable contradictory evidence (here the poor state of *T. arnoldi* holotype must be taken into account, as must the absence of information about its live coloration) I would conclude that *Tilapia arnoldi* Gilchrist and Thompson, 1917, should be treated as a junior subjective synonym of *Tilapia sparrmanii* A. Smith, 1840, and not, as Regan (1922) first suggested and Barnard (1948*a*,*b*) subsequently formalized, a synonym of *Oreochromis mossambicus* (Peters), 1852.

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